

Head Injuries: Neurosurgical and Automotive Perspectives

Stephen Fuks*, Martin Lambrecht**, Hugh Garton

Carla Kohoyda-Inglis, Alice Yan, Theresa Kennedy, Elizabeth Link, June Lee, Pam Snider, Joel MacWilliams, Larry Schneider, Stewart C. Wang

*Visteon Corporation, **Johnson Controls, Inc.
University of Michigan Program for Injury Research and Education

Selection Criteria

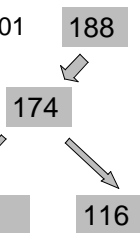
- CIREN PATIENTS 1997 – 2001

- ISS>9

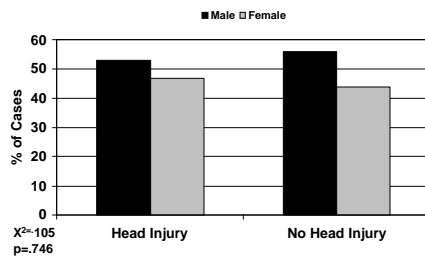
- Head Injury Defined

HEAD MAIS 3

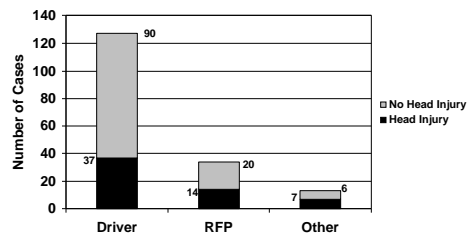
58
Head Injured



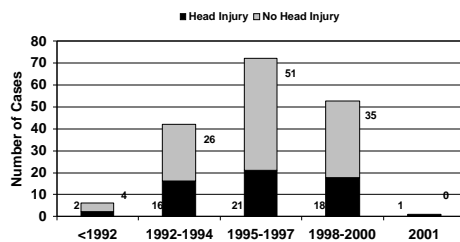
Injury by Gender



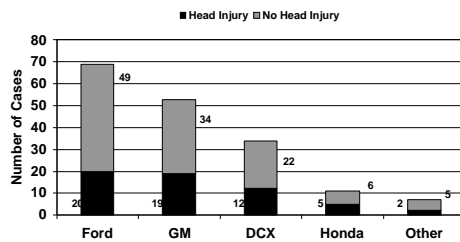
**Distribution of Case Occupant Position
(N=174)**



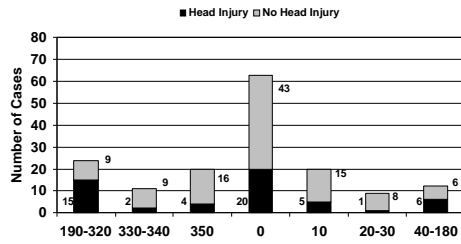
**Distribution of Case Occupant Vehicle
Model Year (N=174)**



**Distribution of Case Vehicle Manufacturer
(N=174)**

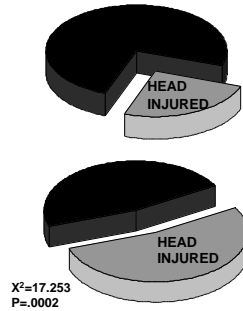


Distribution of Case Vehicle by PDOF (N=159 – excludes roll over & unknown)



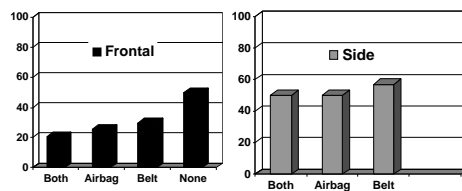
Impact Type

- Frontal Impact (n = 133)
Head Injury = 34
No Head Injury = 99
- Side Impact (n = 32)
Head Injury = 17
No Head Injury = 15
- Other (n = 9)

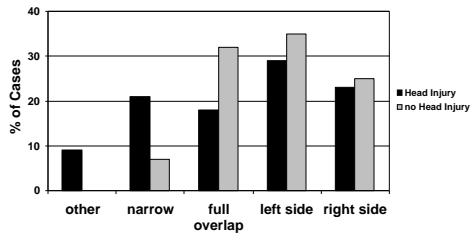


Risk of Head Injury by Restraint

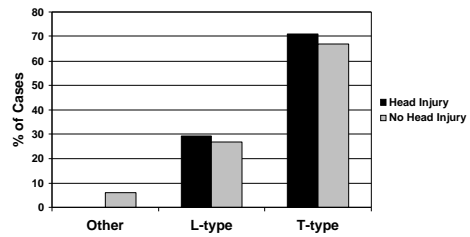
Probability
of Head
Injury



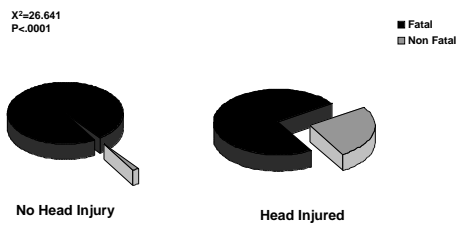
Frontal Impact: Effect of Crash Subtype on Head Injury



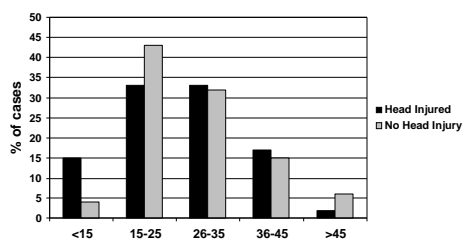
Side Impact: Effect of Crash Subtype on Head Injury



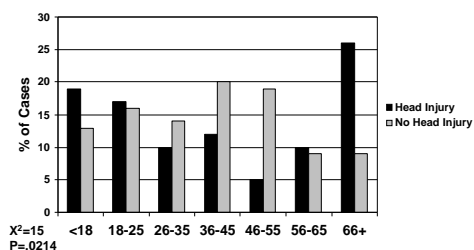
Fatality On Head Injury



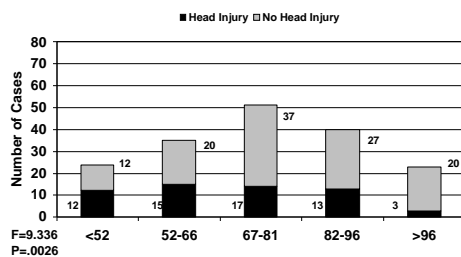
Effect of Delta V on Head Injury



Age Distribution on Head Injury



Distribution of Case Occupant Weight, kg (N=173)



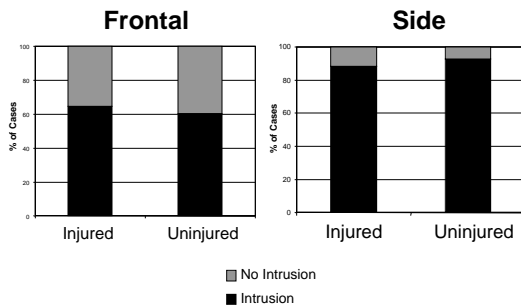
Crash Summary

- Head injuries more common in side impact versus frontal impact cases.
- Minor decrease of head injuries in **frontal** crash cases where **frontal** air bags are present.
- Head injury risk increased in older case occupants for both frontal and side impacts.
- Head injury risk decreased in heavier case occupants for both frontal and side impacts.

Intrusion Definitions

- Head Region Intrusion:
Intrusion at or above beltline in occupant's seating area of vehicle

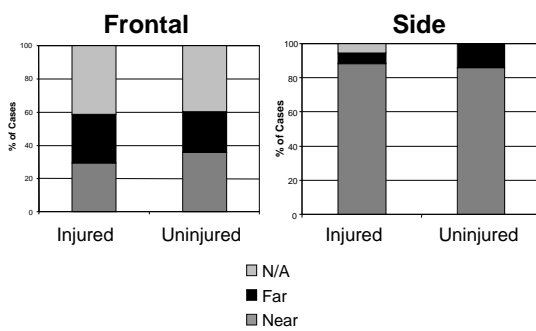
Effect of Head Region Intrusion on Head Injury
Frontal and Side Impacts



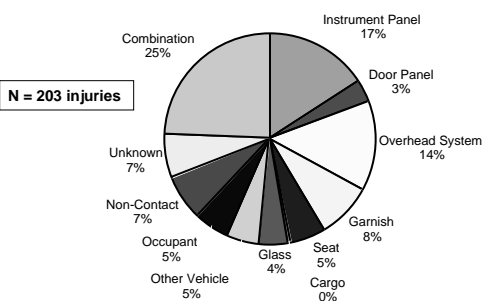
Near / Far Position Definitions

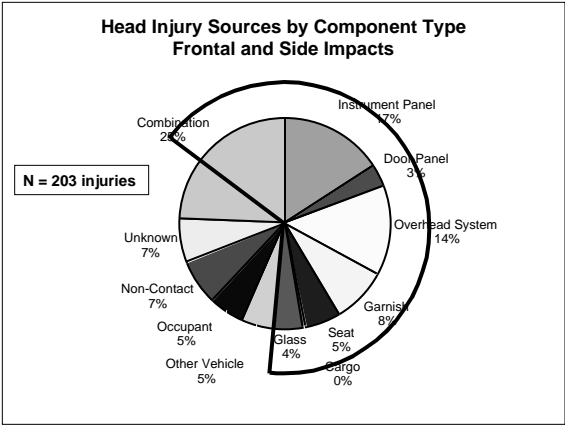
- Near:
On occupant's side
- Far:
Opposite from occupant's side
- N/A:
Not classifiable as near or far

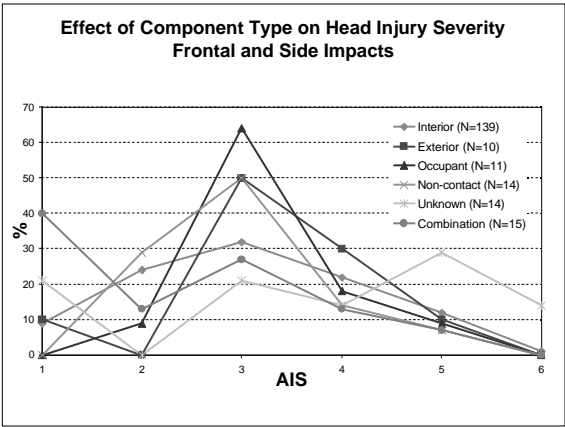
**Effect of Near / Far Position on Head Injury
Frontal and Side Impacts**

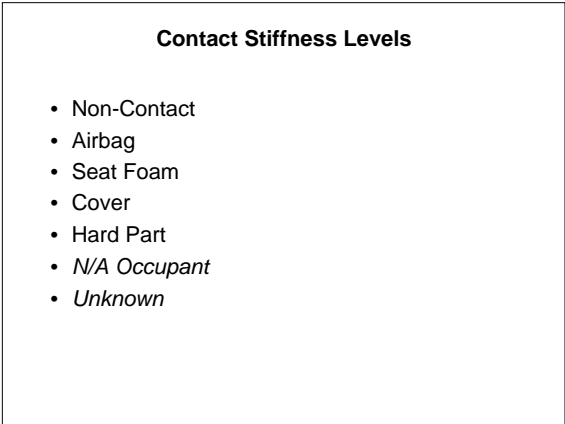


**Head Injury Sources by Component Type
Frontal and Side Impacts**









Contact Stiffness Levels

- Non-Contact
- Airbag
- Seat Foam
- **Cover**
- Hard Part
- *N/A Occupant*
- *Unknown*

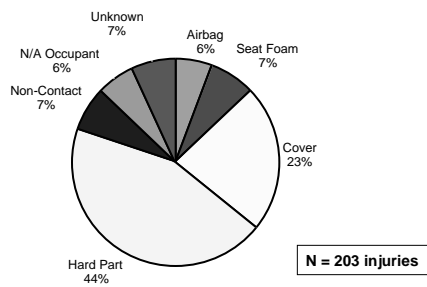


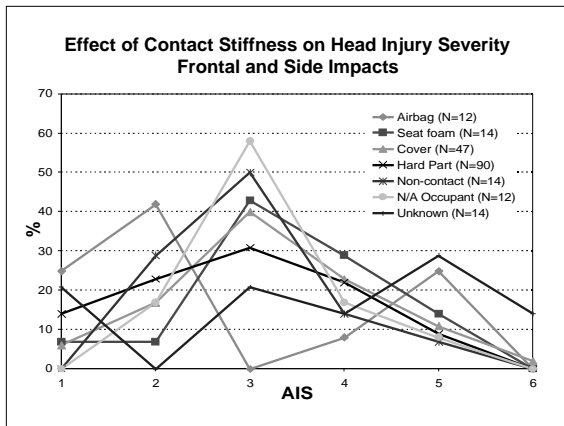
Contact Stiffness Levels

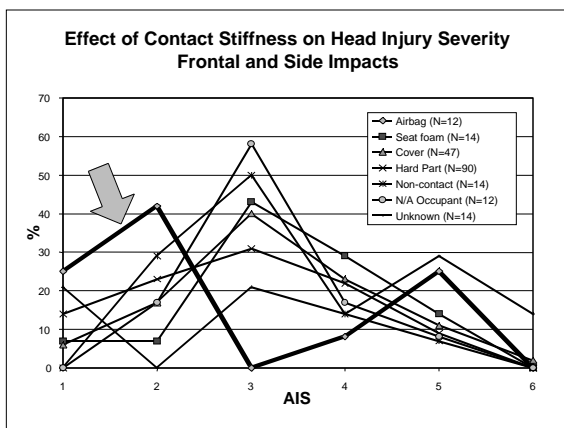
- Non-Contact
- Airbag
- Seat Foam
- Cover
- **Hard Part**
- *N/A Occupant*
- *Unknown*



Head Injury Sources by Contact Stiffness Frontal and Side Impacts




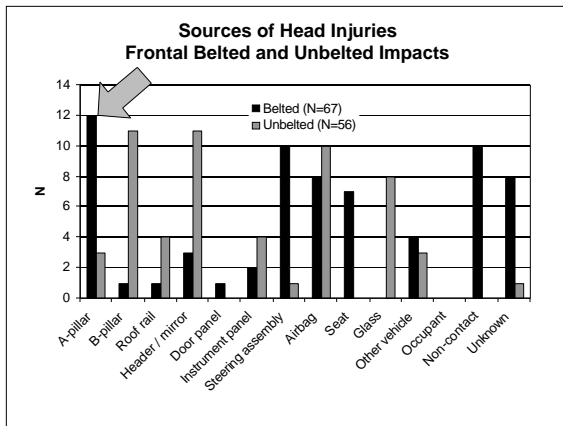


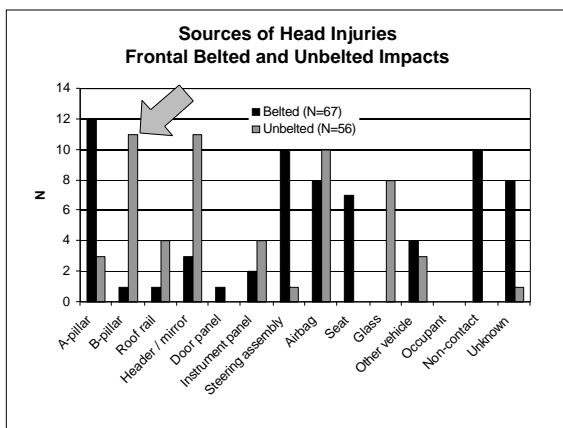


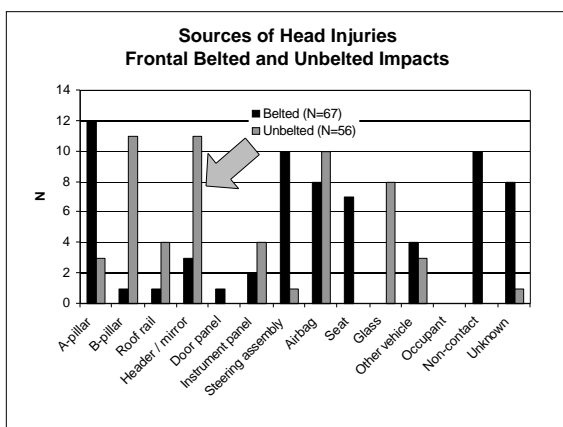
Caveat

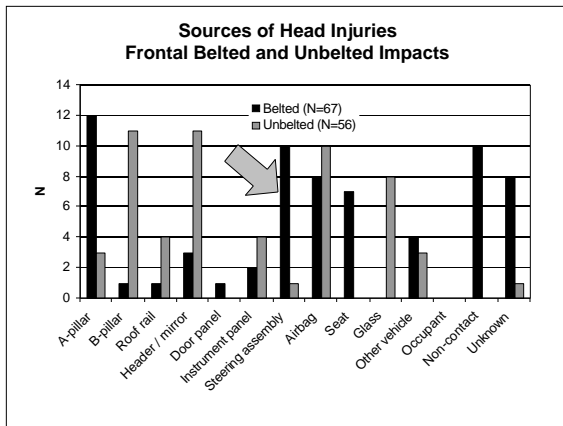
- No vehicle in this study had FMVSS 201U head impact countermeasures
- Phase-in of countermeasures into fleet currently underway
- Crash investigator training?

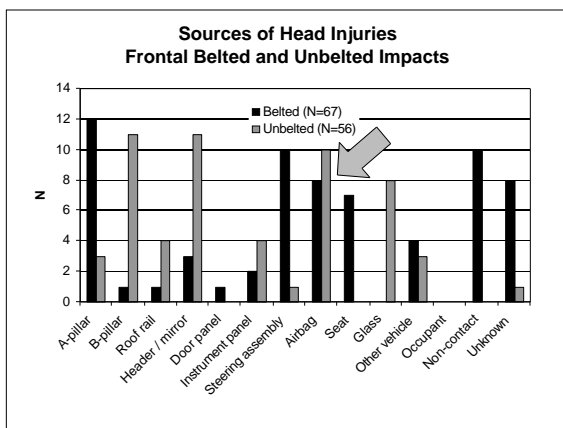


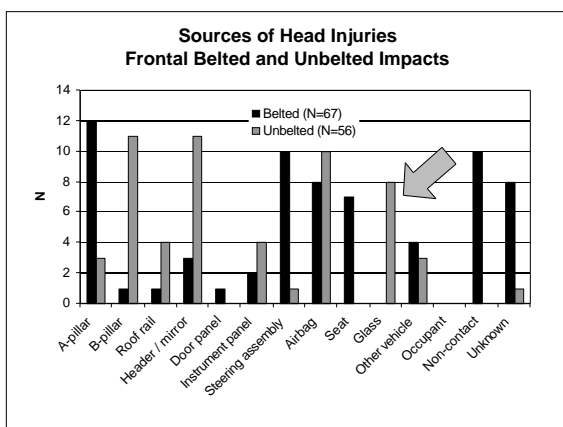


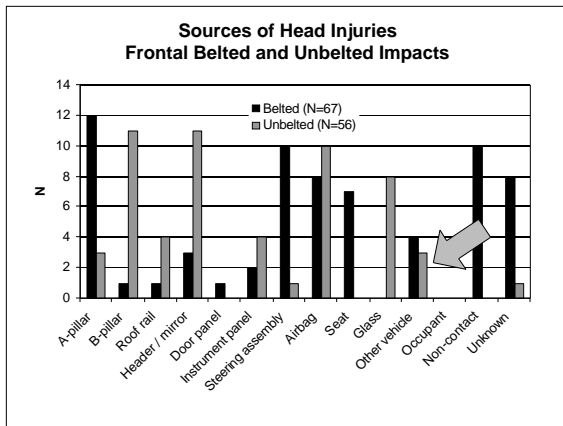


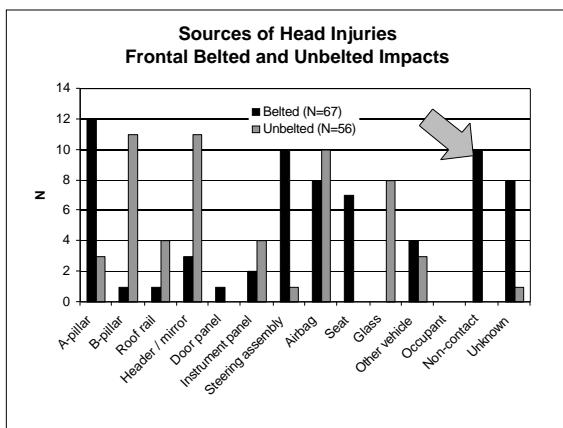


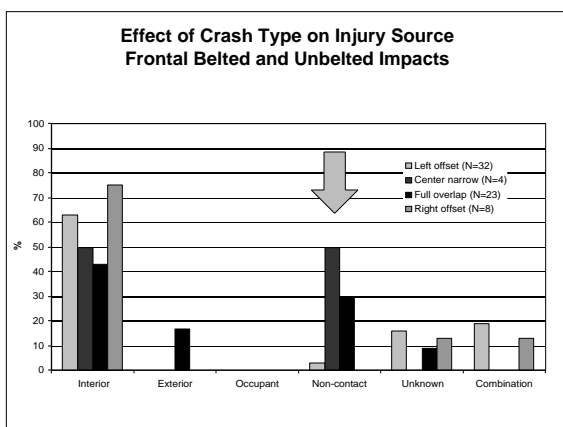


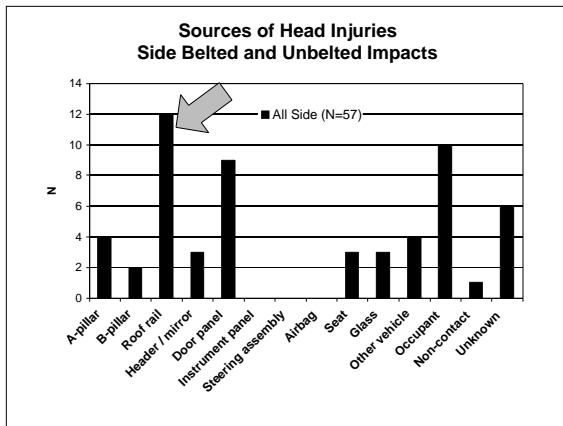


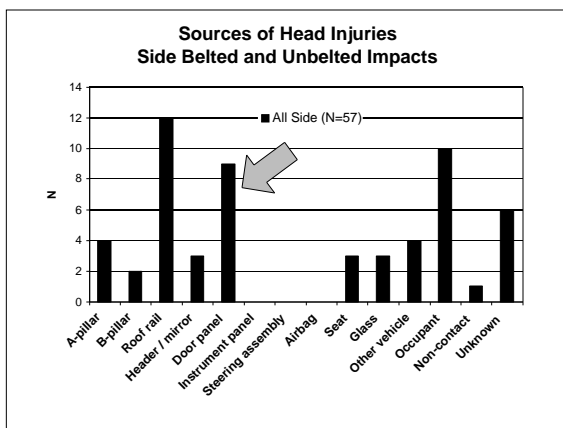


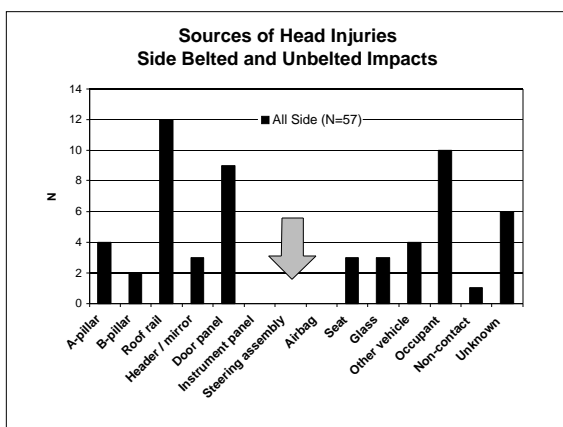


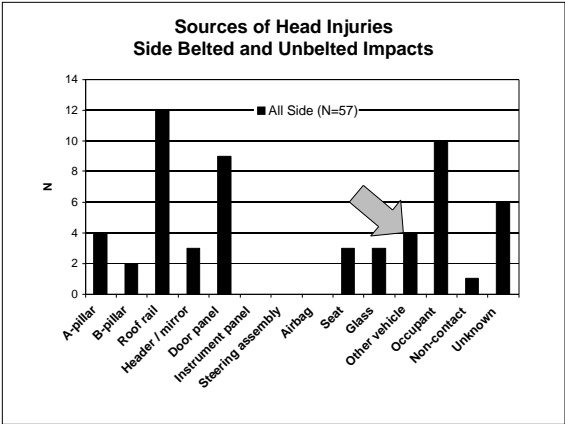


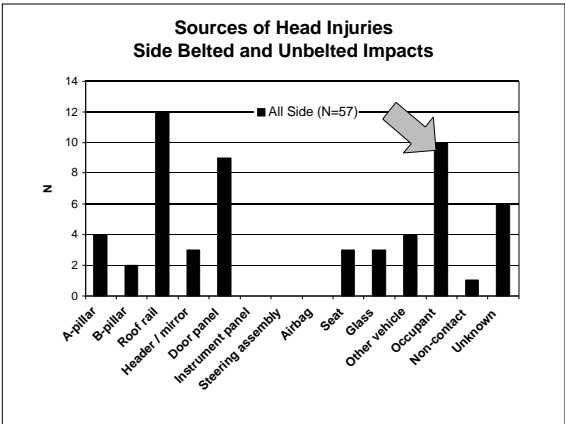


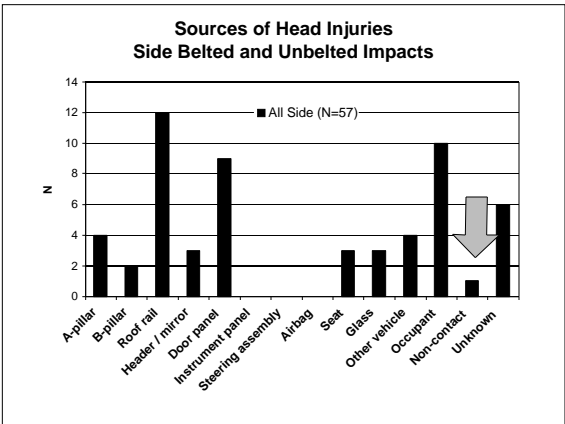












Vehicle Summary

- The presence of head region intrusion is not associated with increased head injury risk
- Near-side occupant position is not associated with increased head injury risk
- Among injury sources, the most common injury severity is AIS 3
- Among contact stiffness levels, the most common injury severity is AIS 3 (except airbags)
- Airbag contact injury severities are shifted to either side of AIS 3

Vehicle Summary

- Frontal impacts:
Only belted occupants sustained non-contact injuries
Non-contact injuries are very prevalent in center narrow object crashes
- Side impacts:
Non-contact injuries are not prevalent
Another vehicle occupant is often the source of injury
The number of injuries attributed to an intruding vehicle similar to that observed in frontal impacts

Neurological Questions

- Injury scores predict neurological outcome?
- Change in injury patterns frontal vs. side impact?
- Effects of countermeasures on injury severity?

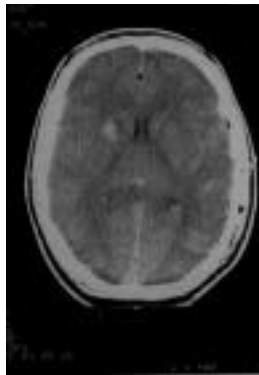
Neurological Severity Assessment

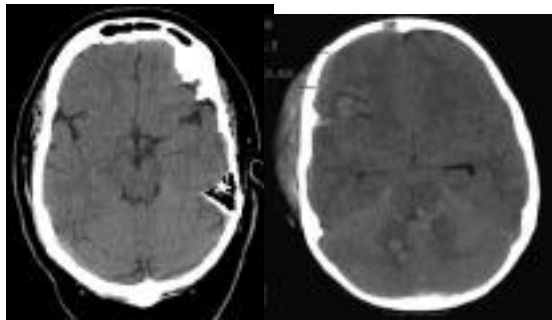
- AIS scores (Head Region): 1-6
- Clinical: GCS → mGCS
- Radiographic
Marshall Criteria: Diffuse injury scale

Marshall Criteria

- I Normal Head CT scan
- II Lesions, Cisterns Open, No shift
- III Cisterns Effaced, No Shift
- IV Midline Shift >5mm, no clot >25cc
- V Evacuated Mass >25cc
- VI Non Evacuated Mass >25cc
- VII *Lethal Head Injury*

Diffuse Injury II





Normal

Diffuse Injury III

Diffuse
Injury IV



Outcome Prediction MAIS 1H

		Outcome (GOS) at 3 months				Total
		1	3	4	5	
MAIS1H	6	3				3
	5	5	6	2		13
	4	4	2	1	13	20
	3	5	1	4	12	22
Total		17	9	7	25	58

Outcome Prediction MAIS 1H

	Sick	Outcome (GOS) at 3 months				Total
		1	3	4	5	
MAIS1H	6	3				3
	5	5	6	2		13
	4	4	2	1	13	20
	3	5	1	4	12	22
Total		17	9	7	25	58

Healthy

Outcome Prediction MAIS 1H

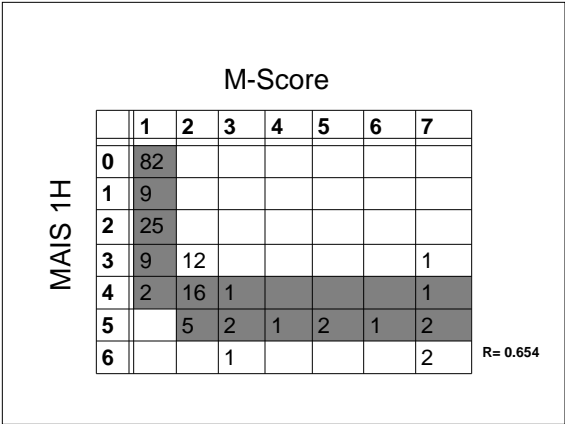
	Sick	Outcome (GOS) at 3 months				Total
		1	3	4	5	
MAIS1H	6	3				3
	5	5	6	2		13
	4	4	2	1	13	20
	3	5	1	4	12	22
Total		17	9	7	25	58

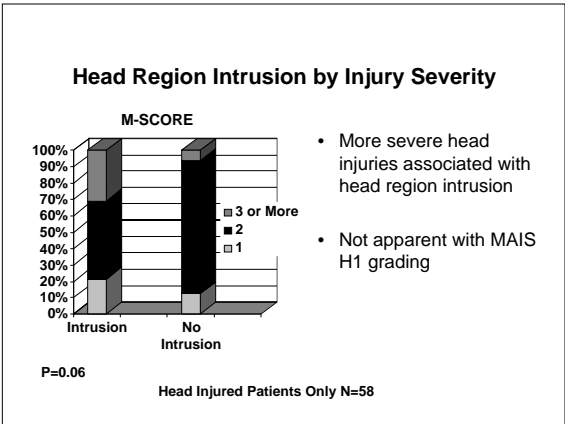
Healthy

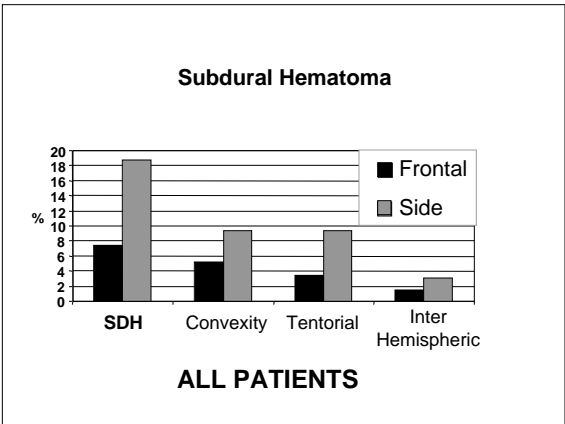
Correlations

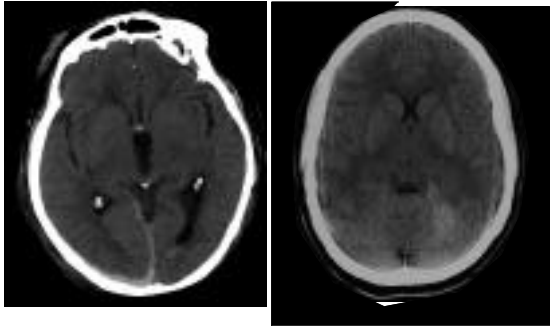
	GOS 3M	GOS 6M
MAIS 1H	0.418	0.357
M GCS	0.517	0.504
M-Score	0.610	0.564

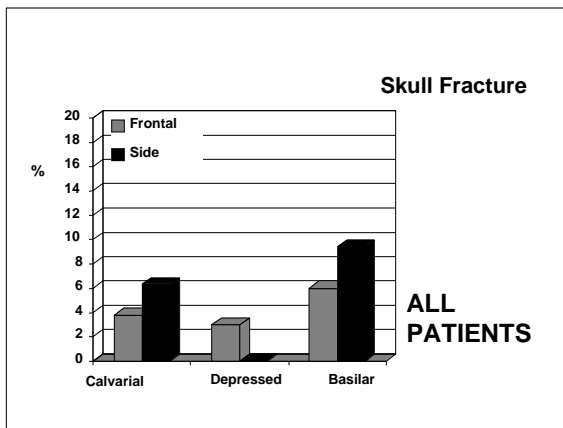
Pearson's R

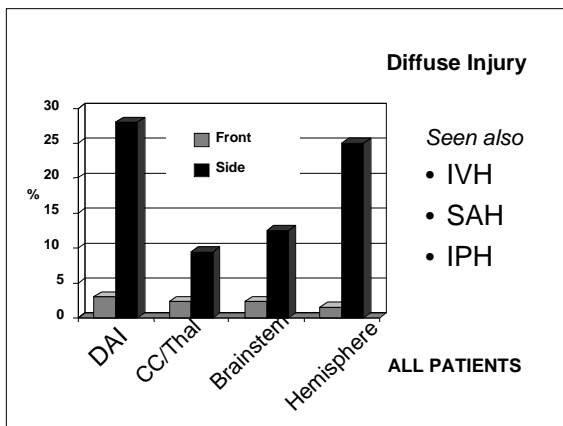


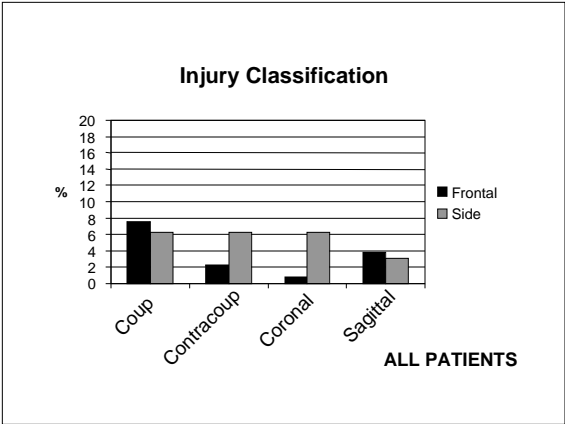








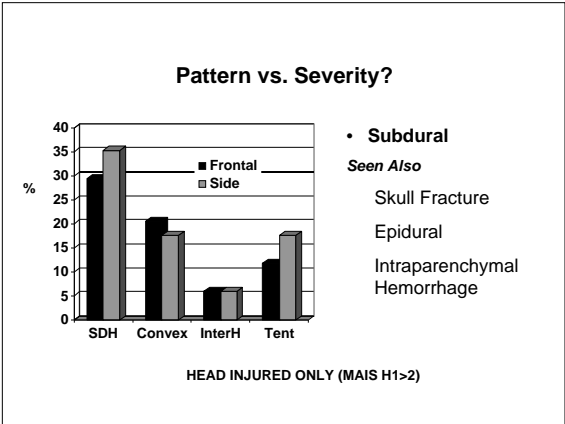




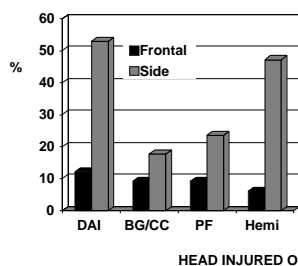
Frontal vs. Side Impact

• Injury Severity

		IMPACT		Total
		Frontal	Side	
Mais1H	0-2	99	15	114
	3-4	24	13	37
	5-6	10	4	14
Total		133	32	165



Pattern vs. Severity



- Diffuse Axonal Injury

Seen also

- Subarachnoid Hemorrhage
- Intraventricular Hemorrhage

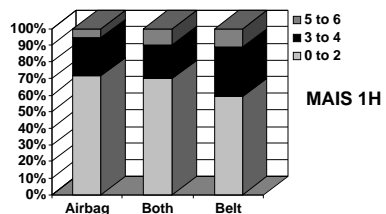
HEAD INJURED ONLY (MAIS H1>2)

Fatalities: Competing Risk

	IMPACT		Total
	Frontal	side	
Not HI Related	7 58.3%	7 77.8%	14 66.7%
HI Related	5 41.7%	2 22.2%	7 33.3%
	12 100.0%	9 100.0%	21 100.0%

Front or Side Accidents: Fatalities Only

Restraint Use vs. Injury Severity



Neurological Summary

- Do injury scores predict outcome?

YES

- MAIS – good at less severe injuries
- Marshall based Score
 - good at more severe injuries

Neurological Summary

- Different injury patterns: Frontal vs. Side?

YES

- Side Impact: Diffuse Injury, SAH, IVH

Not accounted for just by injury severity

Neurological Summary

- Does belt vs. airbag use change injury severity?

Maybe

- Minor trend towards increase MAIS and M-Score in belt only group.

??

Steve Fuks
Martin Lambrecht
Hugh Garton, MD
